REMARKS

The above amendments are intended to place this case in condition for allowance over the principal reference cited to date, WO98/34755 as well as the U.S. Patent No. 6,231,691 which is cited in the Information Disclosure Statement accompanying this amendment.

The following points are additionally noted:

1) The upper limits on Ag of the 2.0 wt.% avoids overlap with the teaching of WO98/34755. This level of Ag helps lower the cost of the product and suppresses the increase in liquidus temperature caused by the addition of Ni.

2) The wording "copper leaching" has been changed to "copper dissolution" in the specification in order to apply language more commonly used for this phenomenon in the U.S. This is simply an improvement in translation and does not constitute new matter.

3) Obviousness rejections.

a) Earlier in the prosecution of this case, the Examiner argued that the then-claimed features of the invention were substantially disclosed in WO98/34755.

In the amended claims, the range of Ag has been narrowed from 1.0 to 2.0 wt.%. The range of Cu has been narrowed from 0.4 to 0.9 wt.% and the claims have been amended to require that the claimed solder have a liquidus temperature of 240°C or lower. Also, the reference to the presence of Fe has been deleted. As a result, it is believed that the claimed invention, particularly in terms of Ag and Cu percentages, is outside of the teaching of WO98/34755 and is neither anticipated nor rendered obvious by that reference.

b) In WO98/34755, a Sn-Ag-Cu eutectic solder is modified with Ni and/or Fe to enhance high temperature microstructural stability and thermal-mechanical fatigue strength without decreasing solderability. (See Abstract)
WO98/34755 calls for the addition of Ag to a eutectic solder containing 4.7 wt.% of Ag and 1.7 wt.% of Cu, where Ag is set in a range from 3.5 to 7.7 wt.% or from 3 to 4 wt.%. No other disclosure is seen.

Moreover, in the second paragraph of page 8 of WO98/34755, a range of Ag of 3 wt.% or greater is explained. No disclosure nor teaching to a range of Ag of 2 wt.% or lower is seen.

c) Furthermore, in WO98/34755, a range of Ni of 1 wt.% or lower is disclosed. However, an extremely narrow range of 0.02 to 0.06 wt.% of Ni (and that of 0.02 to 0.06 wt.% of Fe) as shown in the amended claim 1 of the invention is not disclosed or taught.

Concerning the range of Cu, in the second paragraph of page 8 of WO98/34755, two concrete examples are disclosed. The first example contains 3.5 to 7.7 wt.% of Ag, 1 to 4 wt.% of Cu, and 1 wt.% or less of Ni. The second example contains 3 to 4 wt.% of Ag, 0.5 to 4 wt.% of Cu, and 1 wt.% or less of Ni.

d) The features of the solder of the invention as claimed in amended claim 1 are the selected ranges of Ag, Cu, and Ni, and the liquidus temperature of 240 °C or lower. WO98/34755 fails to disclose and teach the Ag and Cu ranges of the invention as claimed.

Moreover, the extremely narrow range of 0.02 to 0.06 wt.% of Ni (and that of 0.02 to 0.06 wt.% of Fe) as shown in the amended claim 1 of the invention is not disclosed nor taught in the reference WO98/34755. This range was presented by the present invention.

Therefore, the solder of the invention as claimed in the amended claim 1 is quite different from the solder disclosed in WO98/34755.

Taking the extremely narrow range of 0.02 to 0.06 wt.% of Ni (and that of 0.02 to 0.06 wt.% of Fe), the invention as claimed may be called as a "selection invention" which is neither taught nor suggested in WO98/34755.

e) The following explanation is intended to present additional grounds for establishing the patentability of the invention.

(i) From Tables 11 to 15 in the English specification of the present application and the Additional Table attached herewith, Documents 1 to 3 are derived as attached herewith.

In the Additional Table, sample Nos. 73 - 78 (Ag = 1 wt%) are shown in Table 9 of the present application, sample Nos. N 18 – N 34 (Ag = 2 wt%) were newly added based on the experiment carried out by the

inventors in the same way as shown in the English specification, and the sample Nos. N 35 - N38 were made by the inventors according to the concrete examples shown on page 11 of WO98/34755, and added based on the experiment carried out by the inventors in the same way as shown in the English specification.

Document 1 includes six graphs showing the relationship between the liquidus temperature (°C) and the Ni content (wt.%) of the Sn-Ag-Cu-Ni solder according to the invention, where the Ag content is set at 0.5, 1, 2, 3.5, 4, and 5 wt.% and the Cu content is fixed at 0.8 wt.%. Part of these relationships is shown in Fig. 6 of the present application.

The first graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 0.5 wt.% and Cu = 0.8 wt.%. This graph is easily derived from formed by the samples 62 to 67 in Table 9 and their corresponding points are arranged from right to left in the graph.

The second graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 1 wt.% and Cu = 0.8 wt.%. This graph is easily derived from samples 73 to 78 in Table 9 and their corresponding points are arranged from right to left in the graph.

The third graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 2 wt.% and Cu = 0.8 wt.%. This graph is easily derived from samples N18 to N23 in Additional Table and their corresponding points are arranged from right to left in the graph.

The fourth graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 3.5 wt.% and Cu = 0.8 wt.%. This graph is easily derived from samples 1 to 6 in Table 6 and their corresponding points are arranged from right to left in the graph.

The fifth graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 4 wt.% and Cu = 0.8

wt.%. This graph is easily derived from samples 84 to 89 and their corresponding points are arranged from right to left in the graph.

The sixth graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 5 wt.% and Cu = 0.8 wt.%. This graph is easily derived from samples 95 to 100 and their corresponding points are arranged from right to left in the graph.

(ii) Document 2 includes four graphs showing the relationship between the liquidus temperature (°C) and the Ni content (wt.%)of the Sn-Ag-Cu-Ni solder according to the invention, where the Cu content is set at 0.4, 0.8, 1.2, and 1.6 wt.% and the Ag content is fixed at 3.5 wt.%.

The first graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 3.5 wt.% and Cu = 0.4 wt.%. This graph is easily derived from samples 29 to 34 in Table 7 and their corresponding points are arranged from right to left in the graph.

The second graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 3.5 wt.% and Cu = 0.8 wt.%. This graph is easily derived from samples 1 to 6 in Table 6 and their corresponding points are arranged from right to left in the graph.

The third graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 3.5 wt.% and Cu = 1.2 wt.%. This graph is easily derived from samples 40 to 45 in Table 8 and their corresponding points are arranged from right to left in the graph.

The fourth graph shows the relationship between the liquidus temperature (°C) and the Ni content (wt.%) at Ag = 3.5 wt.% and Cu = 1.6 wt.%. This graph is easily derived from samples 51 to 56 in Table 8 and their corresponding points are arranged from right to left in the graph.

(iii) Document 3 includes two graphs showing the relationship between the liquidus temperature (°C) and the Cu content (wt.%)of the Sn-Ag-Cu solder according to the invention, where the Ag content is set at 1 and 2 wt.%.

The first graph shows the relationship between the liquidus temperature (°C) and the Cu content (wt.%) at Ag = 1 wt.% without Ni. This graph is easily derived from the data set on the third line in Table 4.

The second graph shows the relationship between the liquidus temperature (°C) and the Cu content (wt.%) at Ag = 2 wt.% without Ni. This graph is easily derived from the data set on the fourth line in Table 4.

(iv) As shown in Fig. 6 of the present application and as seen from the graphs of Document 1, the liquidus temperature of the Sn-Ag-Cu-Ni solder rises dependent on the increase of the Ni content. From the graphs in Document 1, it is seen that the rising rate of the liquidus temperature increases as the Ag content increases.

Compared with the case where Ag = 1 wt.% and the case where Ag = 2 wt.%, the liquidus temperature further rises by approximately 5 °C at Ni = 0.06 wt.% when Ag = 3.5 wt.%. If Ag = 4 wt.%, the liquidus temperature further rises by approximately 7 °C at Ni = 0.06 wt.%. If Ag = 5 wt.%, the liquidus temperature further rises by approximately 12 °C at Ni = 0.06 wt.%.

In this way, the rising effect of the liquidus temperature with addition of Ni is gradually enhanced according to the increase of the Ag content. This means that addition of Ni to a Sn-Ag-Cu solder induces a synergistic effect with Ag on the rise of the liquidus temperature.

Therefore, to suppress the liquidus temperature at 240 °C or lower of the Sn-Ag-Cu-Ni solder, as seen from the graphs of Document 1, it is necessary that the Ni content is 0.06 wt.% or less and that the Ag content is 4 wt.% or lower.

In particular, to suppress the liquidus temperature at 230 °C or lower (which is more preferred), as seen from the graphs of Document 1, it is necessary that the Ni content is 0.06 wt.% or less and that the Ag content is 3.5 wt.% or lower.

Moreover, where the Ag content is kept in the range from 1.0 to 2.0 wt.%, as shown in the amended claim 1, the rise of the liquidus

temperature is effectively suppressed even if the Ni content is 0.06 wt.%, i.e., the Ni content is at the maximum value in the range of 0.02 to 0.06 wt.%. (This is also seen from the graph in Fig. 11 of the present application.)

(v) WO98/34755 fails to disclose the fact that addition of Ni to a Sn-Ag-Cu solder induces a synergistic effect with Ag on the rise of the liquidus temperature. In other words, WO98/34755 fails to disclose and teach the fact that the rise of the liquidus temperature is excessive if the Ni content exceeds 0.06 wt.%.

Therefore, it cannot be fairly said that WO98/34755 discloses Sn-Ag-Cu-Ni solders whose liquidus temperature is 240 °C or lower. In other words, because the Sn-Ag-Cu-Ni solder disclosed in WO98/34755 contains a greater Ag content and a greater Ni content than those of the present invention, it seems not to have a liquidus temperature of 240 °C or lower.

(vi) As seen from the graphs of Document 2, the liquidus temperature of the Sn-Ag-Cu-Ni solder rises dependent on the increase of the Ni content. Moreover, it is seen that the rising rate of the liquidus temperature is approximately the same regardless of the Ni content.

Compared with the case where Cu = 0.8 wt.% and Ag = 3.5 wt.%, the liquidus temperature further rises by approximately 9 °C at Ni = 0.06 wt.% when Cu = 1.2 wt.%. When Cu = 1.6 wt.%, the liquidus temperature further rises by approximately 16 °C at Ni = 0.06 wt.%. In this way, to suppress the liquidus temperature at 240 °C or lower in the case where the Ni content is 0.06 wt.% or less and the Ag content is 3.5 wt.% or lower, as seen from the graphs of Document 2, it is seen that the Cu content needs to be 1.2 wt.% or lower.

(vii) WO98/34755 discloses solder including Ni exceeding 0.06 wt.% and Cu exceeding 1.2 wt.%. This solder has a liquidus temperature higher than 240 °C based on the teaching of the present invention.

Therefore, it cannot be fairly said that WO98/34755 discloses Sn-Ag-Cu-Ni solders whose liquidus temperature is 240 °C or lower. In other words, because the Sn-Ag-Cu-Ni solder disclosed in the reference WO98/34755 contains

a greater Cu content and a greater Ni content than those of the present invention, it seems not to have a liquidus temperature of 240 °C or lower.

(viii) One of the contributions of the present invention exists in (a) finding the conditions that affect the liquidus temperature of Sn-Ag-Cu-Ni solders and (b) determining the percentages of the ingredients thereof in order to suppress the liquidus temperature at 240 °C or lower. This is not disclosed and taught in WO98/34755.

(ix) In addition, the invention utilizes the good wettability obtainable at about 0.8 wt.% of Cu when Ag is 1 wt.% or greater. This is not disclosed and taught in WO98/34755 as well.

Based on these differences, the invention as claimed is not obvious over WO98/34755.

(x) To clearly distinguish the present invention from WO98/34755, the limitation that the liquidus temperature is 240 °C or lower was added to the rejected claim 1, in addition to the narrowing of the Ag and Cu contents. The solder composition of the invention as amended is therefore quite different from that of WO98/34755.

The upper limit of "2 wt.%" of the Ag range is derived from the graphs in Document 1. Where Ag is 2 wt.% or lower, the liquidus temperature is not raised even if the Ag content is changed from 0 to 0.6 wt. The basis of the lower limit of "1 wt.%" of the Ag range is clearly shown in the original English specification relating the wettability (see Page 14, lines 14-24 of the English specification).

The range of Cu was narrowed to about 0.4 to about 0.9 wt.% in the amended claim 1. This is to suppress the rise of the liquidus temperature, the reason of which is explained below.

As seen from the graphs of Document 3, the liquidus temperature of the Sn-Ag-Cu solder is relatively lowest where the Cu content is 0.8 wt.% (Ag = 1 or 2 wt.%). Moreover, it is seen that the liquidus temperature is approximately the same where the Cu content is 0.4 and 0.9 wt.%, even if the Ag content is changed from 1 to 2 wt.%. This is the reason why the Cu content is limited to the range from about 0.4 and about 0.9 wt.%.

It is respectfully requested that the objections and rejections in the pending office action be withdrawn in view of the amendments and arguments presented above. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

Date: 7/26/04

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ADDITIONAL TABLE

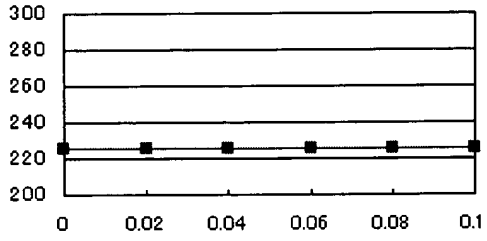
№	Sn	Ag	Cu	Ni	Fe	SOLIDUS TEMP.□□□	LIQUIDUS TEMP.□□□	COPPER DISSOLUTION RATE □μm/sec□	VISCOSITY □□□□	SPREADING RATE □□□	REMARKS
73	98.2	1	0.8	0	0	217	225	0.2	1.7	77	1%Ag (SAMPLES 74-78)
74	98.18	1	0.8	0.02	0	217	225	0.13	1.7	76.8	
75	98.16	1	0.8	0.04	0	217	225	0.09	1.7	77.1	
76	98.14	1	0.8	0.06	0	217	225	0.06	1.7	77.3	
77	98.12	1	0.8	0.08	0	217	225	0.04	1.7	78.1	
78	98.1	1	0.8	0.1	0	217	235	0.03	1.8	77.8	
N18	97.2	2	0.8	0	0	217	225	0.144	2.1	73	2%Ag (ADDED FROM EXPERIMENT)
N19	97.18	2	0.8	0.02	0	217	225	0.114	2	72	
N20	97.16	2	0.8	0.04	0	217	225	0.095	1.9	74	
N21	97.14	2	0.8	0.06	0	217	225	0.072	1.9	75	
N22	97.12	2	0.8	0.08	0	217	226	0.033	1.9	71	
N23	97.1	2	0.8	0.1	0	217	226	0.03	1.9	76	
N29	97.16	2	0.8	0.02	0.02	217	225	0.054	1.8	73	
N30	97.14	2	0.8	0.04	0.02	217	225	0.049	1.8	76	
N31	97.13	2	0.8	0.05	0.02	217	225	0.037	1.9	75	
N32	97.12	2	0.8	0.06	0.02	217	225	0.033	2	75	
N33	97.1	2	0.8	0.08	0.02	217	225	0.021	2.1	75	
N34	97.08	2	0.8	0.1	0.02	217	225	0.02	2	75	
N35	93.3	4.7	1.7	0.3		217	265	0.021	3.5	71	WO9834755
N36	93.45	4.7	1.7	0.15		217	245	0.015	3.4	70	
N37	93.3	4.7	1.7		0.3	217	245	0.042	3.1	72	
N38	95.1	3.6	1	0.3		217	263	0.072	3.5	75	

□DOCUMENT 1□

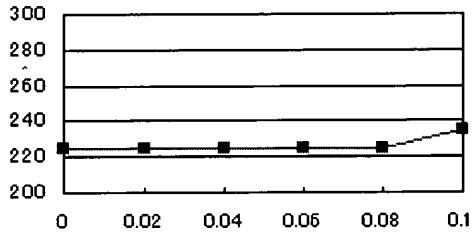
Liquidus Temperature change of Sn-Ag-Cu-Ni solder according to the Invention

(Cu = 0.08 wt%)

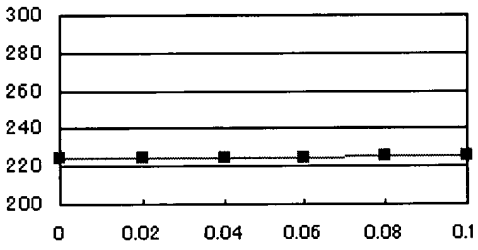
0.5 wt % of Ag Liquidus Temp. (Samples 62-67)



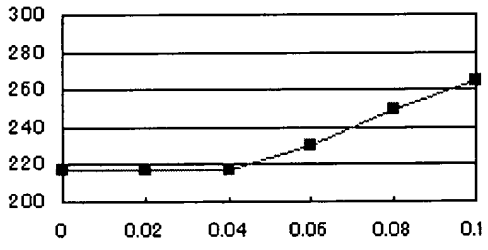
1 wt % of Ag Liquidus Temp. (Samples 73-78)



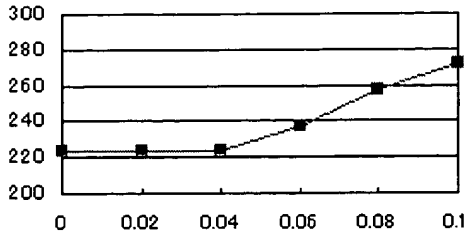
2 wt % of Ag Liquidus Temp. (Samples N18-N23)



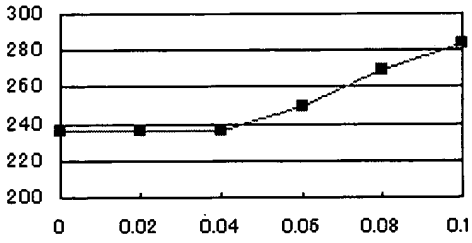
3.5 wt % of Ag Liquidus Temp. (Samples 1-6)



4 wt % of Ag Liquidus Temp. (Samples 84-89)



5 wt % of Ag Liquidus Temp. (Samples 95-100)

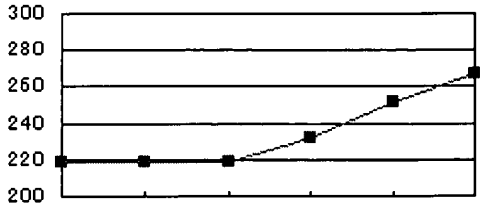


□DOCUMENT 2□

Liquidus Temperature change of Sn-Ag-Cu-Ni solder according to the Invention

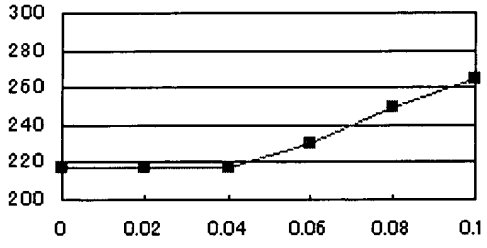
(Ag = 3.5 wt%)

0.4 wt % of Cu Liquidus Temp. (Samples 29-34)



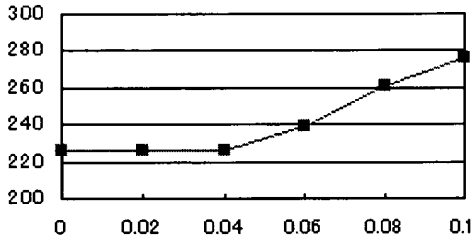
□□□□□□□□ wt % of Ni

0.8 wt % of Cu Liquidus Temp. (Samples 1-6)



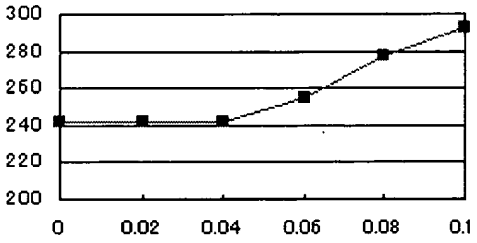
wt % of Ni

1.2 wt % of Cu Liquidus Temp. (Samples 40-45)



□□□□□□□□ wt % of Ni

1.6 wt % of Cu Liquidus Temp. (Samples 51-56)

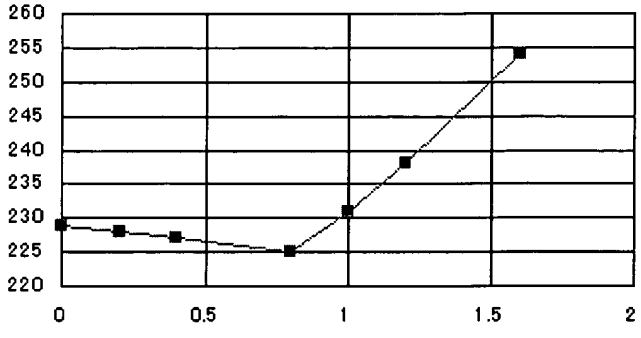


□□□□□□□□ wt % of Ni

□DOCUMENT 3□

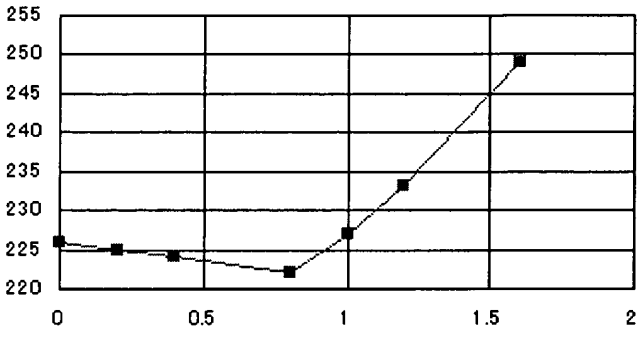
Liquidus Temperature change of Sn-Ag-Cu solder

1 wt % of Ag Liquidus Temp. (Data from third line in Table 4)



□□□□□□□□ wt % of Cu

2 wt % of Ag Liquidus Temp. (Data from fourth line in Table 4)



□□□□□□□□ wt % of Cu